

AMENDMENTS TO CLAIMS

1. (Currently Amended) A method for determining the source of audio signal degradation in an Internet Protocol (IP) telephony environment, the method comprising the computer-implemented steps of:

for each switching device of a set of a plurality of switching devices that are configured on a network along a path between a first endpoint and a second endpoint, storing a reference version of an audio signal waveform at an originating device; transmitting, from the originating device to the switching device, the reference version of the audio signal waveform; receiving at the originating device from the switching device a second version of the audio signal waveform that represents the waveform after transmission at least to the switching device; computing at the originating device audio signal degradation that occurred between the originating device and the switching device by comparing the reference version of the audio signal waveform with the second version of the reference version of the audio signal waveform; determining which switching device along the path between the first endpoint and the second endpoint is the source of audio signal degradation in a path between the first endpoint and the second endpoint based on the audio signal degradations associated with each of the switching devices of the set of switching devices; and storing an identifier of the source of audio signal degradation.

2. (Previously Presented) The method of claim 1, wherein the step of computing audio signal degradation includes computing audio signal degradation with a perceptual measure.
3. (Previously Presented) The method of claim 1, wherein the step of computing audio signal degradation includes computing audio signal degradation using Perceptual Evaluation of Speech Quality (PESQ) techniques.
4. (Canceled)
5. (Currently Amended) The method of claim [[4]] 1,
wherein the step of receiving includes receiving the second version of the audio signal waveform over a reliable Transmission Control Protocol (TCP) connection after the switching device timestamps packets that it received that correspond with the reference version of the audio signal waveform that was transmitted by the originating device and buffers the packets before sending them to the originating device over the reliable TCP connection; and
wherein the step of computing the audio signal degradation consists of computing the audio signal degradation that occurred in a path from the originating device to the switching device.
6. (Previously Presented) The method of claim 1,
wherein the step of receiving includes receiving the second version of the audio signal waveform at the originating device from the switching device; and

wherein the step of computing the audio signal degradation consists of computing the audio signal degradation that occurred in a round-trip path between the originating device and the switching device.

7. (Previously Presented) The method of claim 1, wherein the step of receiving includes receiving the second version of the audio signal waveform at the switching device; and wherein the step of computing includes computing the audio signal degradation at the switching device.
8. (Previously Presented) The method of claim 7, further comprising the computer-implemented step of: for each switching device of a set of switching devices, receiving from the switching device a measure of the audio signal degradation that was computed at the switching device.
9. (Original) The method of claim 1, further comprising the computer-implemented step of: determining the set of network switching devices that are configured on the network between the first endpoint and the second endpoint.
10. (Original) The method of claim 1, further comprising the computer-implemented step of: determining the set of network switching devices that are configured on the network between the first endpoint and the second endpoint by determining a set of network switching devices that are in a path from the first endpoint to the second endpoint.

11. (Original) The method of claim 10, further comprising the computer-implemented step of:

determining the set of network switching devices that are configured on the network between the first endpoint and the second endpoint by determining the set of network switching devices that are configured in a path from the second endpoint to the first endpoint.
12. (Original) The method of claim 11, wherein the path from the first endpoint to the second endpoint is different than the path from the second endpoint to the first endpoint.
13. (Original) The method of claim 1, wherein the set of switching devices comprises every switching device configured on a path between the first endpoint and the second endpoint.
14. (Original) The method of claim 1, wherein the set of switching devices comprises a subset of the switching devices configured on a path between the first endpoint and the second endpoint.
15. (Original) The method of claim 1, wherein the step of transmitting is performed for each switching device of the set of switching devices in a sequential order from a switching device that is nearest to the first endpoint to a switching device that is nearest to the second endpoint.
16. (Original) The method of claim 1, wherein the steps are performed by one or more intermediate network switching devices.

17. (Original) The method of claim 1, wherein the steps are performed by one or more network routers.
18. (Currently Amended) A method for determining audio signal degradation in a path of an Internet Protocol (IP) telephony environment, the method comprising the computer-implemented steps of:

at a network switching device of a plurality of switching devices that are configured on a network along a path between a first endpoint and a second endpoint,
receiving from an originating device connected to the network, at a network switching device, a reference version of an audio signal waveform; and
transmitting to the originating device a second version of the reference version of the audio signal waveform that represents the audio signal waveform after transmission at least to the network switching device, for computing audio signal degradation that occurred in a path between the originating device and the network switching device by comparing the reference version of the audio signal waveform with the second version of the reference version of the audio signal waveform, and for determining whether the network switching device along the path between the first endpoint and the second endpoint is the source of the audio signal degradation.
19. (Original) The method of claim 18, wherein the steps are performed by an intermediate network switching device.
20. (Original) The method of claim 18, wherein the steps are performed by a network router.

21. (Previously Presented) The method of claim 18, wherein the reference version of the audio signal waveform is received as a series of packets, the method further comprising the computer-implemented steps of:
 - attaching a timestamp to each of the packets of the series of packets;
 - buffering each of the packets of the series of packets;
 - wherein the step of transmitting comprises, upon receiving the complete series of packets that represent the reference version of the audio signal waveform, transmitting the second version of the reference version of the audio signal waveform to the originating device over a reliable Transmission Control Protocol (TCP) connection, for computing the audio signal degradation that occurred in a path from the originating device to the switching device.
22. (Original) The method of claim 21, wherein the steps are performed by an intermediate network switching device.
23. (Original) The method of claim 21, wherein the steps are performed by a network router.
24. (Currently Amended) A computer-readable storage medium storing one or more sequences of instructions for determining the source of audio signal degradation in an Internet Protocol (IP) telephony environment, which instructions, when executed by one or more processors, cause the one or more processors to carry out the steps of:
for each switching device of a set of a plurality of switching devices that are configured on a network along a path between a first endpoint and a second endpoint, transmitting, from an originating device to the switching device, a reference version of an audio signal waveform;

receiving a second version of the reference version of the audio signal waveform that represents the waveform after transmission at least to the switching device;

computing audio signal degradation that occurred between the originating device and the switching device by comparing the reference version of the audio signal waveform with the second version of the reference version of the audio signal waveform; and

determining which switching device along the path between the first endpoint and the second endpoint is the source of audio signal degradation in a path between the first endpoint and the second endpoint based on the audio signal degradations associated with each of the switching devices of the ~~set of~~ switching devices.

25. (Previously Presented) The computer-readable storage medium of claim 24, wherein the instructions cause the one or more processors to carry out the step of computing audio signal degradation by computing audio signal degradation with a perceptual measure.
26. (Previously Presented) The computer-readable storage medium of claim 24, wherein the instructions cause the one or more processors to carry out the step of computing audio signal degradation by computing audio signal degradation using Perceptual Evaluation of Speech Quality (PESQ) techniques.
27. (Previously Presented) The computer-readable storage medium of claim 24, wherein the instructions cause the one or more processors to carry out the step of receiving by

receiving the second version of the reference version of the audio signal waveform at the originating device from the switching device.

28. (Previously Presented) The computer-readable storage medium of claim 27, wherein the instructions cause the one or more processors to carry out the step of receiving by receiving the second version of the reference version of the audio signal waveform over a reliable Transmission Control Protocol (TCP) connection after the switching device timestamps packets that it received that correspond with the reference version of the audio signal waveform that was transmitted by the originating device and buffers the packets before sending them to the originating device over the reliable TCP connection; and the step of computing the audio signal degradation by computing the audio signal degradation that occurred in a path from the originating device to the switching device.
29. (Previously Presented) The computer-readable storage medium of claim 24, wherein the instructions cause the one or more processors to carry out the step of receiving the second version of the reference version of the audio signal waveform at the originating device from the switching device; and the step of computing the audio signal degradation by computing the audio signal degradation that occurred in a round-trip path between the originating device and the switching device.
30. (Previously Presented) The computer-readable storage medium of claim 24, wherein the instructions cause the one or more processors to carry out

the step of receiving the second version of the reference version of the audio signal waveform at the switching device; and
the step of computing by computing the audio signal degradation at the switching device.

31. (Previously Presented) The computer-readable storage medium of claim 30, wherein the instructions cause the one or more processors to carry out:
for each switching device of a set of switching devices, receiving from the switching device a measure of the audio signal degradation that was computed at the switching device.
32. (Previously Presented) The computer-readable storage medium of claim 24, wherein the instructions cause the one or more processors to carry out:
determining the set of network switching devices that are configured on the network between the first endpoint and the second endpoint.
33. (Previously Presented) The computer-readable storage medium of claim 24, wherein the instructions cause the one or more processors to carry out:
determining the set of network switching devices that are configured on the network between the first endpoint and the second endpoint by determining a set of network switching devices that are in a path from the first endpoint to the second endpoint.
34. (Previously Presented) The computer-readable storage medium of claim 33, wherein the instructions cause the one or more processors to carry out:
determining the set of network switching devices that are configured on the network between the first endpoint and the second endpoint by determining the set of

network switching devices that are configured in a path from the second endpoint to the first endpoint.

35. (Previously Presented) The computer-readable storage medium of claim 34, wherein the path from the first endpoint to the second endpoint is different than the path from the second endpoint to the first endpoint.
36. (Previously Presented) The computer-readable storage medium of claim 24, wherein the set of switching devices comprises every switching device configured on a path between the first endpoint and the second endpoint.
37. (Previously Presented) The computer-readable storage medium of claim 24, wherein the set of switching devices comprises a subset of the switching devices configured on a path between the first endpoint and the second endpoint.
38. (Previously Presented) The computer-readable storage medium of claim 24, wherein the instruction cause the one or more processors to carry out the step of transmitting by transmitting to each switching device of the set of switching devices in a sequential order from a switching device that is nearest to the first endpoint to a switching device that is nearest to the second endpoint.
39. (Previously Presented) The computer-readable storage medium of claim 24, wherein the steps are performed by one or more intermediate network switching devices.
40. (Previously Presented) The computer-readable storage medium of claim 24, wherein the steps are performed by one or more network routers.

41. (Currently Amended) A computer- readable storage medium storing one or more sequences of instructions for determining audio signal degradation in a path of an Internet Protocol (IP) telephony environment, which instructions, when executed by one or more processors, cause the one or more processors to carry out the steps of:

at a network switching device of a plurality of switching devices that are configured on a network along a path between a first endpoint and a second endpoint,

receiving from an originating device connected to the network, at a network switching device, a reference version of an audio signal waveform; and

transmitting to the originating device a second version of the reference version of the audio signal waveform that represents the audio signal waveform after transmission at least to the network switching device, for computing audio signal degradation that occurred in a path between the originating device and the network switching device by comparing the reference version of the audio signal waveform with the second version of the reference version of the audio signal waveform, and for determining whether the network switching device along the path between the first endpoint and the second endpoint is the source of the audio signal degradation.

42. (Previously Presented) The computer-readable storage medium of claim 41, wherein the steps are performed by one or more processors configured on an intermediate network switching device.

43. (Previously Presented) The computer-readable storage medium of claim 41, wherein the steps are performed by one or more processors configured on a network router.

44. (Previously Presented) The computer-readable storage medium of claim 41, wherein the reference file is received as a series of packets, and wherein the instructions cause the one or more processors to carry out the steps of:
attaching a timestamp to each of the packets of the series of packets;
buffering each of the packets of the series of packets;
wherein the step of transmitting comprises, upon receiving the complete series of packets that represent the reference version of an audio signal waveform, transmitting the second version of the reference version of the audio signal waveform to the originating device over a reliable Transmission Control Protocol (TCP) connection, for computing the audio signal degradation that occurred in a path from the originating device to the switching device.
45. (Previously Presented) The computer-readable storage medium of claim 44, wherein the steps are performed by one or more processors configured on an intermediate network switching device.
46. (Previously Presented) The computer-readable storage medium of claim 44, wherein the steps are performed by one or more processors configured on a network router.
47. (Currently Amended) A system for determining the source of audio signal degradation in an Internet Protocol (IP) telephony environment, the system comprising:
means for transmitting a reference version of an audio signal waveform from an originating device to each switching device of a set of switching devices that are configured on a network between a first endpoint and a second endpoint;

means for receiving a second version of the reference version of the audio signal waveform that represents the waveform after transmission at least to each respective switching device of ~~the set of a plurality of switching devices that are configured on a network along a path between a first endpoint and a second endpoint;~~

means for computing audio signal degradation that occurred between the originating device and each switching device of the set of switching devices by comparing the reference version of the audio signal waveform with the second version of the reference version of the audio signal waveform; and

means for determining ~~which switching device along the path between the first endpoint and the second endpoint is~~ the source of audio signal degradation ~~in a path between the first endpoint and the second endpoint~~ based on the audio signal degradations associated with each of the switching devices of the ~~set of~~ switching devices.

48. (Original) The system of claim 47, wherein the system is configured on a network router.
49. (Currently Amended) A system for determining audio signal degradation in a path of an Internet Protocol (IP) telephony environment, the system comprising:
~~at a network switching device of a plurality of switching devices that are configured on a network along a path between a first endpoint and a second endpoint,~~
means for receiving from an originating device ~~connected to the network, at a~~ ~~network switching device~~, a reference version of an audio signal waveform; and

means for transmitting to the originating device a second version of the reference version of the audio signal waveform that represents the audio signal waveform after transmission at least to the network switching device, for computing audio signal degradation that occurred in a path between the originating device and the network switching device by comparing the reference version of the audio signal waveform with the second version of the reference version of the audio signal waveform, and for determining whether the network switching device along the path between the first endpoint and the second endpoint is the source of the audio signal degradation.

50. (Original) The system of claim 49, wherein the system is configured on a network router.
51. (Currently Amended) A network device that can determine the source of audio signal degradation in an Internet Protocol (IP) telephony environment, the device comprising:
 - a network interface;
 - a processor coupled to the network interface and receiving messages from a network through the network interface;
 - a computer-readable storage medium storing one or more stored sequences of instructions which, when executed by the processor, cause the processor to carry out the steps of:
 - for each switching device of a set of a plurality of switching devices that are configured on a network along a path between a first endpoint and a second endpoint,

storing a reference version of an audio signal waveform at an originating device;

transmitting, from the originating device to the switching device, the reference version of the audio signal waveform;

receiving a second version of the reference version of the audio signal waveform that represents the waveform after transmission at least to the switching device;

computing audio signal degradation that occurred between the originating device and the switching device by comparing the reference version of the audio signal waveform with the second version of the reference version of the audio signal waveform;

determining which switching device along the path between the first endpoint and the second endpoint is the source of audio signal degradation in a path between the first endpoint and the second endpoint based on the audio signal degradations associated with each of the switching devices of the ~~set of~~ switching devices; and

storing an identifier of the source of audio signal degradation.

52. (Currently Amended) A network device that can determine audio signal degradation in a path of an Internet Protocol (IP) telephony environment, the device comprising:

a network interface;

a processor coupled to the network interface and receiving messages from a network through the network interface;

a computer- readable storage medium storing one or more stored sequences of instructions which, when executed by the processor, cause the processor to carry out the steps of:

at a network switching device of a plurality of switching devices that are configured on a network along a path between a first endpoint and a second endpoint,
receiving from an originating device connected to the network, at a network switching device, a reference version of an audio signal waveform; and
transmitting to the originating device a second version of the reference version of the audio signal waveform that represents the audio signal waveform after transmission at least to the network switching device, for computing audio signal degradation that occurred in a path between the originating device and the network switching device by comparing the reference version of the audio signal waveform with the second version of the reference version of the audio signal waveform, and for determining whether the network switching device along the path between the first endpoint and the second endpoint is the source of the audio signal degradation.